Spring 2022 EE214 Experiment 2
Miscellaneous Op-Amp Circuits

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Contents

1 Introduction

In this experiment, miscellaneous op-amp circuits and three different setups of op-amp circuity are investigated. First, an independent current source circuit is set, and its behavior is required to be characterized. Then the clipper circuit is constructed, and the output is needed to be observed. Lastly, a negative resistance converter with two zener is built with two different setups. First, its i-v characteristics are expected to be observed; then, a square wave generator is expected to be set.

2 Experimental Results and Discussion

The results of the experiment are discussed in the following steps.

2.1 Step 1

In this step independent current source circuit given in Figure 1 is constructed. A potentiometer with $10K\Omega$ is connected to the one port as R_L.

Student 1 : Ahmet Akman 2442366
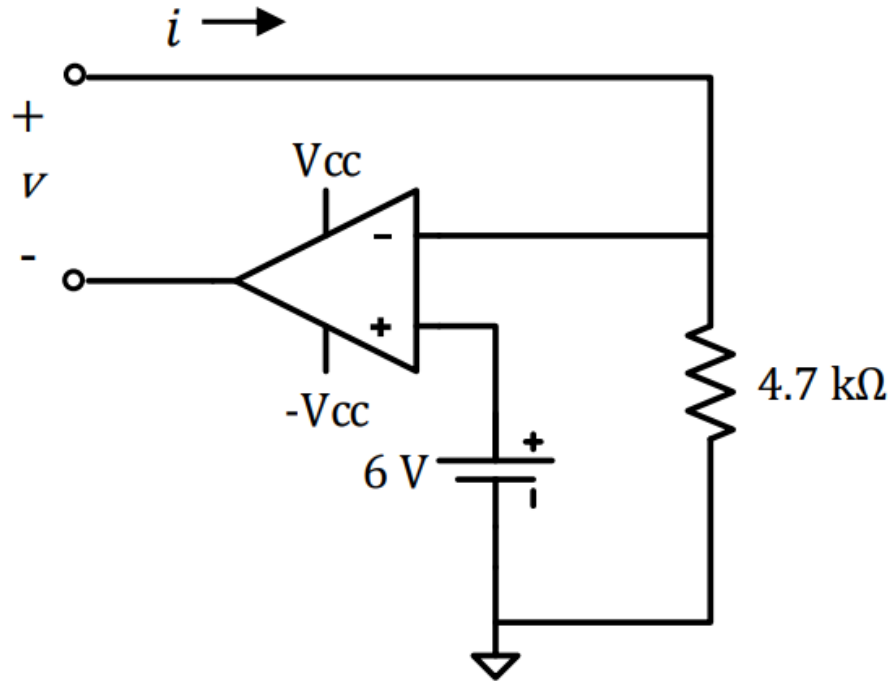Student 2: Yusuf Toprak Yıldıran 2444149
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Figure 1: Circuit schematic for the step 1

To be able to obtain the maximum value of the resistance in which the one port still functions as an independent current source, the potentiometer is meticulously adjusted. So, the parameters given in Table 1 are obtained.

Table 1: Liner region boundary parameters

The Current Value	Corresponding Resistance
1.24 mA	8kΩ

As a result, it can be concluded that the independent current source circuit functions as long as it is in the linear region; however when the op-amp saturates, it is no longer works. So, the circuit acts as an independent current source with 1.24mA until the load resistance is 8kΩ.

2.2   Step 2

In this step, the clipper circuitry given in Figure 3 is constructed. V_{in} is set to $3sin(1000\pi t)$ from the signal generator.
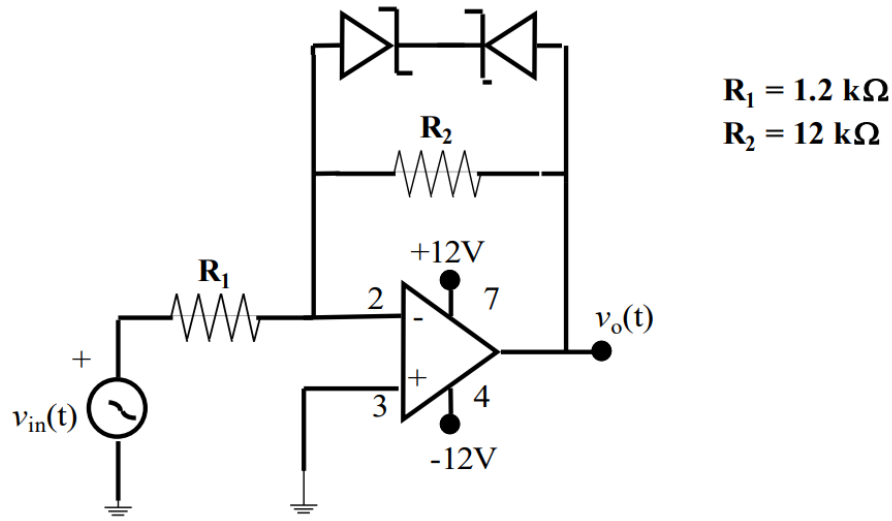
Figure 2: Clipper circuit schematic for the step 2

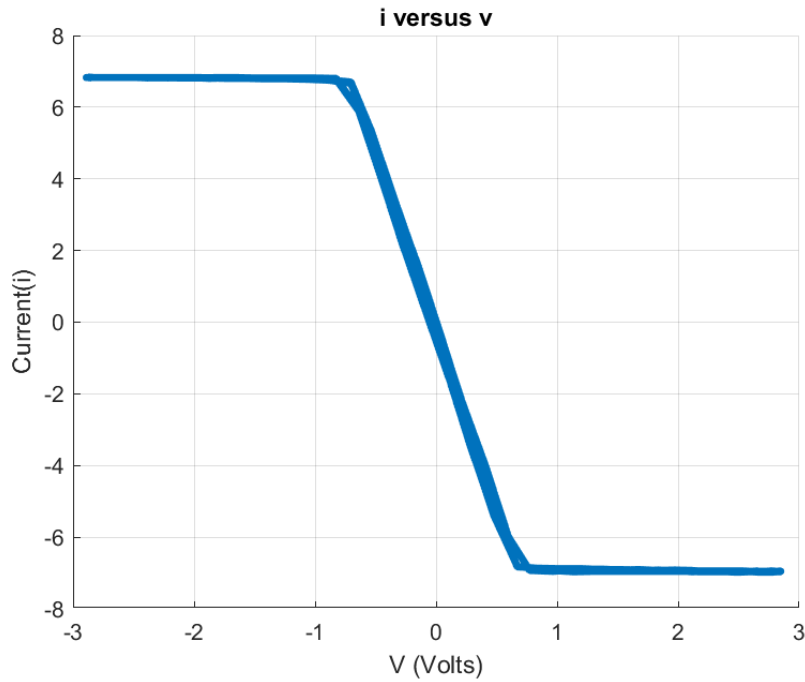The plot given in Figure 4 is obtained as a result of V_o vs V_{in}.

Figure 3: V_o vs V_{in}

So it is observed that saturation voltages are not +12 and -12 Volts. This result is stemmed from the fact that in saturation regions, zener diodes are both open, but one from forwarding and another from the reverse. Which results in the sum of their forward opening voltage ($\approx 1V$) and reverse-opening voltage ($\approx 6V$) to be 7 Volts. In the saturation region,

they switch the forward-reverse and results in $\approx 14VV_{pp}$

2.3   Step 3

In this part, we set the negative resistance converter circuit given in Figure 4 below.
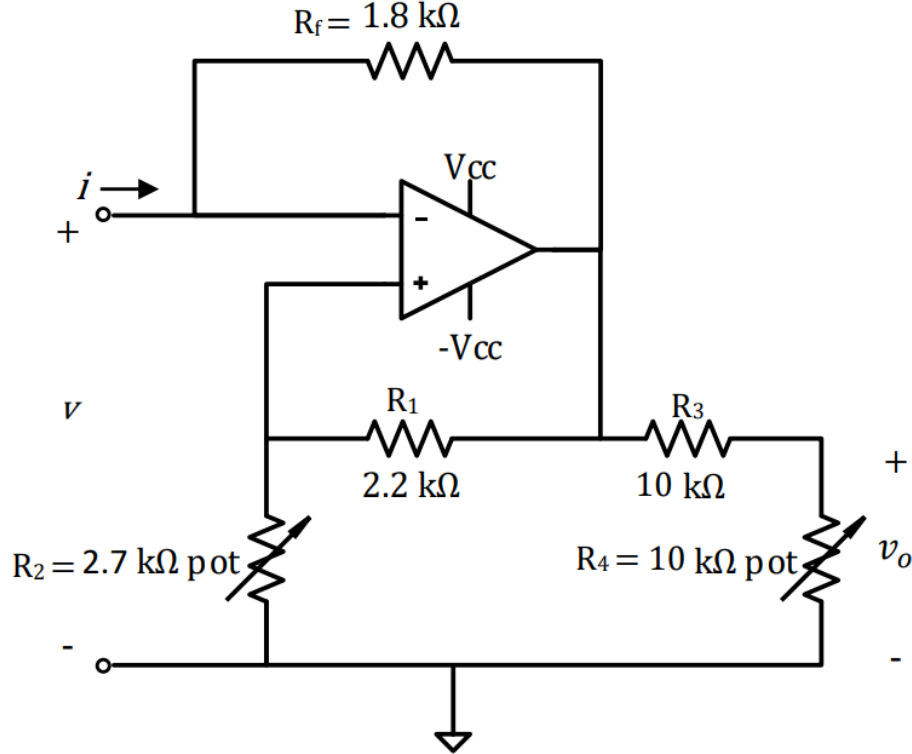

Figure 4: Circuit schematic for the step 3

2.3.1   a)

For this part a., we used 1.2kΩ instead of the R_2 2.7kΩ pot and adjusted the V as $V(t) = 10sin(\pi t)V$ and obtained the i vs v characteristics by using DSO in X-Y mode in Figure 5. To obtain current i, we connected 1kΩ resistor between common ground and non-inverting input port of the op-amp and measured the voltage across it, by doing this, we get the current in mA. Also, voltage v is obtained by measuring the input signal. From the oscilloscope, it can be seen that op-amp goes into + saturation or - saturation without being into linear region and the circuit is unstable.
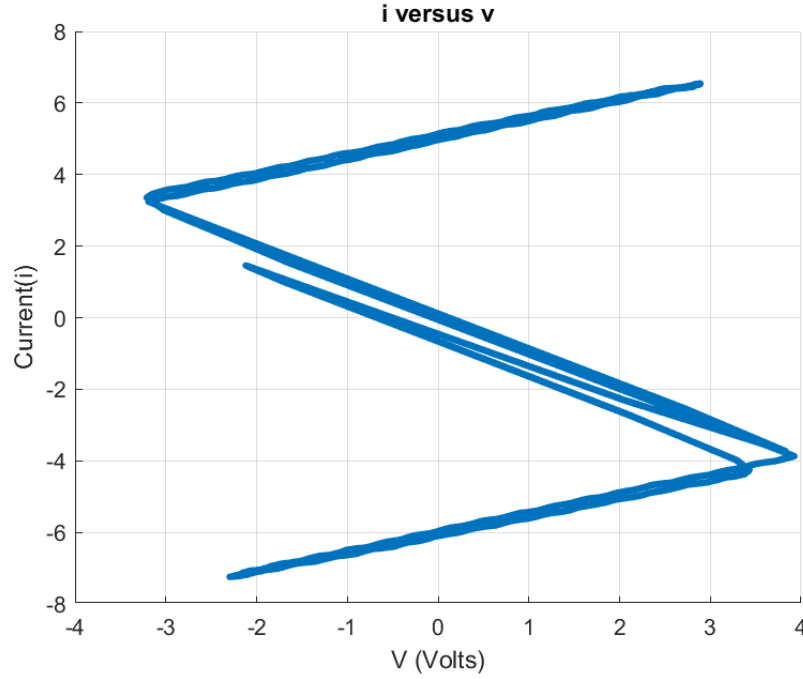
Figure 5: $i(t)$ vs V_t

2.3.2   b)

In this subsection b. a $1\mu F$ capacitor is connected across the terminals between this one port circuit and R_2 and R_4 are adjusted until $V_0(t)$ become a square wave of 2 volts peak-to-peak with the frequency of 500Hz. Then, R_2 and R_4 are recorded using a digital multimeter as a table which is given in the Table 2. It can be observed that experimental values are partially consistent with the preliminary work results given in Table 3. Also time constant τ is found by multiplying R_f with the capacitance of the capacitor given in Table 2.

Table 2: Experimental Results of R_2,R_4 and τ.

R_2	R_4	τ
0.46kΩ	2.4kΩ	1.8x10^{-6}s

Table 3: Preliminary Work Results of R_2 and R_4.

R_2	R_4
1.63kΩ	2kΩ

Then, $V_C(t)$ and $V_0(t)$ are observed on the DSO screen as seen in Figure 6. From this part b. it can be said that an adjustable square wave signal can be obtained without applying

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an input signal to a negative resistance converter and the frequency of this signal can be adjusted by changing the potentiometer R_2 and the amplitude can be adjusted by changing the R_4.
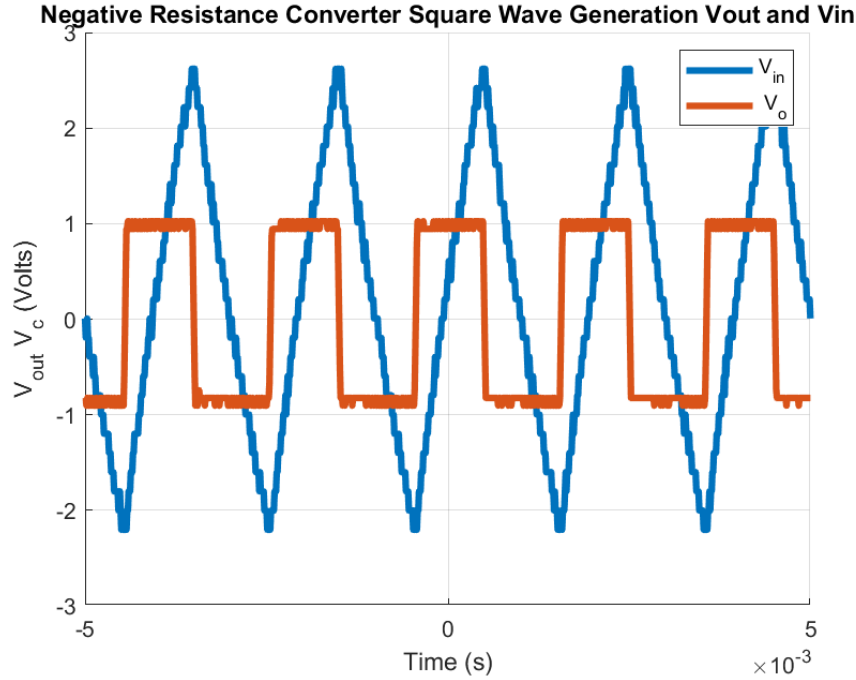

Figure 6: $V_C(t)$ $V_0(t)$ vs Time

3   Conclusion

In this experiment, miscellaneous op-amp circuits have experimented with three different op-amp setups: independent current source, clipper, and negative resistance converter. First, it is observed where the independent current source works and the maximum load resistance obtained. Then it is observed that the behavior of the clipper circuit explained the reason why saturation regions are different. Lastly, a negative resistance circuit is constructed. Its one port i-v characteristics are obtained, then a square wave generator is configured with the same setup with the help of a capacitor. The target frequency and amplitude values are achieved, and the variables are noted. To sum up, in this experiment, three different setups of the op-amp are investigated.

Appendix A

- PreLab Preparation 4 hours

- Experimental Work 2 hours

- Report Writing 4 hours